

With the author's compliments.

AN ORTHOPEDIC VIEW
OF THE
TREATMENT OF FRACTURES.

BY

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AN ORTHOPEDIC VIEW OF THE TREATMENT OF FRACTURES.

In an article on fractures written by an orthopedic surgeon, it is natural that the subject should be treated rather from the point of view that every fracture is potentially a deformity, and if it becomes a deformity will lead to impairment of function.

The object of treatment is the restoration of complete function with least risk and inconvenience to the patient and with least anxiety to the surgeon.

In attaining this object a clear idea is needed of the disabilities and deformities most likely to occur after fractures in each particular region, and also of the difficulties in treatment peculiar to each.

The smooth working of a limb depends on preserving the true axis of movement of the joints, so that the stresses of muscular action may act across the joint in normal lines. Otherwise, abnormal stresses will produce abnormal strains for we are dealing with living bone, in accordance with Wolff's law, which is the physiological equivalent of that universal law: Strain is proportional to stress.

In dealing with fractures of the shafts of long bones the first consideration therefore is to secure and maintain a true anatomical alignment of the bone so that the axis of movement of the joints at the two ends of the bone may retain their correct relative positions. The best results are naturally obtained when the fragments at the seat of fracture are brought into correct reposition. Experience, however, has proved that meticulous exactness in replacing every fragment is not necessary to a perfectly good functional result.

In carrying out this principle of treatment every surgeon must frame for himself his own rules of procedure, being governed by his own experience of success with manipulative methods or with direct operative attack on the seat of fracture and applying splints immediately on the bone in the form of plates and screws. Those who have a large and varied experience of the manipulative treatment of deformity will probably have greater confidence in their ability to deal with deformities resulting from fractures by manipulation and external splinting. They will reserve direct operation for those cases in which they have found that their manipulative skill has not proved equal to retaining the limb in a correct position until union of the fragments has taken place.

In referring to particular fractures, the writer will therefore be drawing on his own experience with his own methods of securing that correct alignment which is the first object of every surgeon when

called on to treat a fracture of a shaft of a long bone.

In this connection, it is not amiss to say that the virtue of a splint lies not so much in its particular form, but in the way in which it is used. At the same time every workman carefully selects the tools he uses, and has his favorites among them. In this respect the author is conscious that he has his favorite splints, but believes that for the purposes for which he uses them, and in the way in which he employs them, they are the most suitable, most efficient, and most immediately available that he can find.

It is sometimes stated that the object of a splint is to keep the parts immovable. While this is true, it is desirable to remember that the first object is to maintain the alignment. For this purpose the traditional wooden board, still often used, is not the best, and is often a trap for the unwary practitioner. No human limb will fit a flat board. If a limb is bandaged to a flat board firmly enough to make it immovable, the parts above and below the fracture may easily be put out of alignment. Of this, the treatment of fractures of the femur with the long Liston splint, has furnished many examples. A further objection is that a cylindrical limb only touches a flat splint along a line. Thus, if the bandaging be really firm there is a risk of undue pressure atrophy along this line. If thin metal is used (sheet iron of the same thickness as 24 wire gauge) this trouble is very largely overcome, and

sheet iron can be got from the village smith as easily as a plank from the carpenter. Sheet iron of this thickness can easily be twisted or squeezed by hand to fit the varying curves of the limb, and yet being gutter-shaped, is quite rigid longitudinally. Further, having a curved cross-section and being slightly flexible, it distributes the pressure more evenly round the limb and not along a line. Hence the limb can be really firmly bandaged to the splint without fear of producing pressure sores. Of course in both instances the hollows in the limb must be suitably padded to avoid pressure on bony prominences, but in the case of thin metal splints this is much easier.

In dealing with fractures near joints or involving the articular ends of bones, difficulties of treatment are greater.

True alignment, especially of the axis of movement, is still of paramount importance, but there is also the difficulty that small fragments of displaced bone which would be of little importance in a fracture of the shaft, may here get in the way and effectively block movement by their mechanical obstruction.

The ends of long bones consist of cancellous bone containing red marrow. They are extremely vascular, and ready to undergo growth changes on very slight provocation, hence any conditions which maintain local irritation will tend to increase the amount of new bone formation with consequent obstruction of movement.

In purely traumatic cases these changes are known as traumatic osteoarthritis, but they arise chiefly from undue irritation by movement, occurring in the stages of repair. At this time, the area is more vascular than normal, and the whole osseous structure of the part is therefore more susceptible to strains arising from stress of weight carrying. Examples of this will be found notably at the ankle and hip. Another factor is the stress of muscular action which, of course, is a factor in all cases, but in the upper limb it takes precedence of gravity.

This leads us to the consideration of the fact that muscles and tendons cross the joint, and are often attached to the ends of the bone near the joint. They may be the surgeon's worst enemies or his best friends in the treatment of a fracture about or involving a joint, according to whether he uses them correctly or wrongly. As an illustration of this point no joint serves better than the elbow. At one time it was customary to attempt treatment of fractures about the condyles of the humerus, which are so common in children, on a right-angled internal splint. Frequently the result was a "gun-stock" elbow with the lower end drawn backward, often also displaced outward by pressure of the splint on the internal condyle, while the lower end of the upper fragment of the humerus projected forward, helping with its associated callus to produce a complete mechanical obstruction to flexion. Here, once the backward displacement of the lower

fragment has begun, the triceps tendon will keep pulling the olecranon back and up. Any play means a see-saw struggle between the biceps and brachialis anticus and the triceps, with a continuous slight irritation of the part and a maximum formation of exudate and of osteogenetic formation in that exudate.

Now that these fractures are almost universally treated in the fully flexed position, the tendon of the triceps forms a comfortable, close-fitting posterior splint, any fragments in front are pushed out of the way and mechanical block to flexion cannot occur. The joint can be kept at complete rest without any play and therefore disturbing reflex contractions of the muscles do not occur, and fractures of this type have ceased to have terrors for the surgeon.

When absolute rest from movement is to be insisted on as a condition necessary for reducing the formation of obstructive callus to a minimum, some rule must be formulated to guide the surgeon when movement of the joint is again to be resumed. Here the old rule laid down by Owen Thomas can be taken as the first guide, namely, that a joint which is tender to palpation is not ready for movement. This tenderness means that excessive vascularity is still present in the bone, surrounding periosteum and tissues, and therefore that any attempt at movement will certainly injure the parts, producing fresh exudate and exciting increased formation of callus.

When this tenderness has entirely disappeared the joint may be moved through a small range of 5° or 10° . If this can be done without pain, a good prognosis may confidently be given. The patient may then be allowed to use the joint through a small range of movement, and if in two or three days the range of movement is increasing, then greater freedom may be permitted. If, however, the joint becomes stiffer and a little painful, then the time for movement has not yet come. A little later comes the time for passive movement. The indication for this is the belief that further movement is prevented by fibrous adhesions and shortening of ligaments. Passive movement should be done once in each direction in which movement is limited. It should not be followed by a reactionary swelling and stiffness which lasts for more than twenty-four hours. If the joint is stiffer twenty-four hours after a single movement it means that it is still not ready for movement, or the movement used has been too violent. To and fro passive movements are very likely to stir up a reaction of an inflammatory nature which leads to more effusion and more adhesions. In all such cases more time is lost by being in a hurry than by waiting a little longer than necessary before trying to restore motion.

So far we have said nothing of massage. At all stages of treatment we believe that massage is beneficial, provided it is of the lightest possible character, and applied with skill without disturbing the fragments, or stimulating the young callus to

fresh overgrowth. When in doubt on this point, it is certainly safer not to massage but to rely on absolute rest.

As we shall see when dealing with malunited fracture, young callus is very susceptible to irritation by shearing forces. Continued pain and tenderness is the great symptom indicating that the repair has not been allowed to become firmly consolidated before the stresses of muscular action or of gravity have been allowed to act on it, thereby keeping up irritation.

NONUNION AND MALUNION.

It is true that there are certain conditions of disease and constitution which retard the union of fractures. The age of the patient is certainly not a direct factor in the production of nonunion, for the most perfect union may occur in the aged and feeble. Setting aside a few cases in which there is some actual condition of disease, experience shows that nearly all cases of "nonunion" are really cases of "delayed union."

This introduces the question of the time it takes for the fracture of any given bone to unite and consolidate. In text-books of surgery definite periods are stated for each, but these are quite unreliable. The period necessary for the complete union and consolidation of a fracture varies in every individual and is a "personal equation" to which sufficient attention is not paid. Not only cases of nonunion,

but as we shall see, cases of malunion are frequently due not to any fault in the method of setting or fixing the fracture, but to the fact that in the individual patient union is slow, requiring twice or even three times the usual period.

Too often the practitioner is hasty in his judgments in this matter. The fracture he is treating shows no evidence of union at the time he expects it, instead of waiting for a week or two he proceeds to disturb the parts, rub the ends together, and start afresh. Again at the appointed time there is "nonunion." When these cases are ultimately sent to consult the writer his usual practice is simply to begin again and wait. By this time there has been a great deal of fibrous repair, and osteogenetic repair has failed. The first thing, therefore, is to wake up the region of the fracture by rough handling to "freshen the ends" of the bone. In doing this, the procedure called "hammer and dam" by Owen Thomas is most effective. After hammering the whole region of the fracture with a padded or India-rubber mallet, a tight elastic band is applied both above and below the fracture at a distance of several inches. This allows the limb in this part to swell to much more than its normal girth, expanding all the capillaries and lymph paths in the fibrous tissue, and allowing a new process of repair to start.

This method of passive congestion was employed by Owen Thomas fifty years ago, long before passive congestion as a means of treatment had attained its present prominence.

The fracture is set in the usual way, and repair is expected in a longer or shorter time. In those cases where the processes of osteogenetic repair are naturally slow nothing is gained by operation, for even after plating the repair process is a delayed one.

In some cases of complicated fracture in which tissue has intervened between the fragments, open operation may be called for, but in the writer's experience the majority of cases of "nonunion" are really unrecognized cases of "delayed union."

Malunion is a large and difficult subject, and while some generalizations can be made, the exceptions are numerous. First of all there is a type of malunion which is closely related to the question of delayed union. A patient with a Pott's fracture receives skilful treatment, the foot is kept well inverted, at the end of six weeks repair in good position is pronounced complete. For six weeks the patient goes gently and then recovering confidence takes more violent exercise. After that he begins to complain of pain about the ankle, and appears to be getting flat-footed. When the surgeon runs his fingers down the fibula he finds tenderness at the seat of fracture. The new bone or callus has been strained, a reaction has set in, the callus is soft and tender, the fibula is bending at the seat of fracture, and the foot is being forced by body weight into the valgus position. All the treatment necessary is to invert the foot by raising the inner side of the heel of the boot, so as to alter the line of the body weight. If the patient is heavy it is as well to add an outside

brace and T strap. This frequently occurs in adults, but its nature is not always recognized. The same thing frequently occurs in children in fractures of both bones in the leg, but in this case the deformity is obvious. Similar straining of the union takes place in the forearm, leading to limitation in pronation and supination ; also at the hip after fractures about the femoral neck often leading to obscure "rheumatic" pains. In every case the trouble is due to straining or shearing of the callus producing an erroneous alignment and throwing the joints out of true. Bearing these facts in mind, it is wise to protect a fracture, especially of the lower limb, from undue stress, even after it appears to be firmly united. On the other hand, it is to be remembered that physiological use is the best agent to assist in making the union solid. It is therefore good practice to let the patient walk as early as possible with a protecting brace for the leg (in a Thomas walking calliper if the fracture is in the femur) or if preferred in an ambulatory plaster splint.

There are other more gross cases of malunion which arise usually from failure to get the fragments into good position when reducing the fracture, or from failure to maintain the parts in good position after it has been reduced.

In some cases it is extremely difficult to get good position or good function on account of complicating injuries. Such cases must be met by the ingenuity of the surgeon as they arise. In consequence of this

difficulty, there is a growing tendency to operate and plate fractures which seem to present difficulties. It must be remembered, however, that efficient bone operations require a considerable degree of special skill, and that an open operation over the seat of a fracture is necessarily a serious consideration to the patient.

It is possible to prevent many of the common forms of malunion with their associated disabilities, by anticipating them in the methods of setting. Some of these will be described in the brief survey of the principal fractures of the bones of the limbs which will be given in the end of this article. Many methods of manipulative treatment which are traditional can be improved on, and by improving our manipulative skill and technic we may hope to frequently avert the necessity of operating.

Similarly it is to be remembered that tenderness at the seat of a fracture is an indication that the callus is not yet hard. It may therefore be broken down by manipulation, and the deformity directly reduced, or it may be corrected by splints or by fixing the limb in a corrective position, just as one can correct a bow-leg or knock-knee by splints, or an active case of coxa vara by extension in the abducted position.

The time that has elapsed since the accident is no indication of the solidity of the union. If the seat of the fracture is tender the callus is soft. Usually the patient complains also that the deformity is growing worse, that is to say, the callus is yielding.

If it can yield in the direction of deformity, it will yield with equal readiness in the direction of correction if proper forces are applied to it.

Turning now to a brief review of the commonest fractures :—

Fractures of the Clavicle.—Fractures of the clavicle are generally well treated, for it is recognized that the general alignment of the bone must be well maintained by keeping the shoulder back and out. The bone is subcutaneous and the practitioner can see and feel the position of the fragments.

Fractures of the Humerus.—In fractures of the neck of the humerus the seat of fracture is deeply situated in muscles and we must be guided by experience.

Dissections and radiographs teach us that in malunions the upper fragment is frequently abducted, and the lower fragment becomes united to its lower side. Clinical experience teaches us that the disabilities which are of greatest practical importance to the patient are limitation of abduction and of external rotation, so that he cannot place his hand at the back of his head.

In reducing this fracture it is often useful to have an assistant extend the limb downward till the fragments clear, then outward to a right angle with the body, and even straight upward by the side of the head. Meanwhile the surgeon with his hand in the axilla and on the arm can feel that the rough broken surfaces have engaged. The arm can then be gently brought to the side, and the arm fixed to the side in the usual manner. There seems to be

little fear of the ends disengaging once they are properly apposed.

When union is sound, passive abduction and rotation once a day will soon re-establish a full range of movement.

When a case comes to me with a stiff shoulder and a limited range of movement, I place more reliance on passive movement, breaking down adhesions first under an anesthetic if necessary.

After fracture of the neck of the humerus, forcible breaking down of adhesions in the shoulder-joint should not be attempted for at least three months, as refracture may occur. During the operation the surgeon should remember that the movement most dangerous is not flexion, but internal and external rotation. In the meantime, an assistant should hold his fist firmly in the axilla to prevent dislocation.

In addition to his daily passive movements, he should practise reaching up the wall with his fingers, making a mark each time at the limit of his stretch, and being careful to surpass it at his next attempt. I have been much struck by the extremely serviceable range of movement obtained by these means.

The so-called fracture of the surgical neck which usually includes both tuberosities with the head is really less troublesome. It occurs usually in old people and is often impacted. In these cases the arm may be left quietly by the side and a very useful

range of movement can be obtained by exercise and passive movement later.

Fracture of the surgical neck complicated by dislocation is much more serious. The maneuver which I have found most useful is that already described of having the arm stretched straight upward by an assistant while the surgeon endeavours to manipulate the head back into position. If this fails, operation may be resorted to, and McBurney's hook is of great service in twisting the upper fragment into place.

Fractures of the shaft of the humerus may be troublesome from two causes—either on account of damage to the musculo-spiral nerve through injury or inclusion in callus, or due to nonunion, the latter being generally caused by inefficient fixation. Many cases of supposed permanent damage to the musculospiral nerve are cured in a few weeks by application of a splint which holds the wrist in dorsiflexion. The patient generally goes about from the beginning of treatment. There is not room for the thick splint frequently employed to lie comfortably in the axilla between the patient's arm and the body, and hence the arm is not as firmly fixed as it should be. Sheet metal splints occupy very little space. The best method I know of setting these fractures, especially when working single-handed, is the following :—First get ready three sheet-metal splints. The external one extends from the external condyle to well above the shoulder, and its upper end is bent over to form

a sort of shoulder cap. A short splint extends from above the internal condyle to the anterior fold of the axilla, and a similar posterior one to the posterior fold of the axilla.

Flex the elbow to an angle of about 60° and sling the wrist to the neck, with the patient sitting in a chair. A loop of bandage is put round the flexure of the elbow, and does not reach the floor. By putting one foot in this loop, the surgeon can apply as much extension as he chooses, while both hands are free to manipulate the fractured ends into correct position. The splints are applied and squeezed up till they fit closely around the arm. A turn of sticking plaster now binds them into a cylinder fitting the arm. A sheet of wadding is then placed between the arm and the chest. The whole is secured with a broad bandage carried over the shoulder and the part of the external splint which is turned over like a shoulder cap. This prevents shortening, for the lower end of the cylinder fits round the arm above the condyles.

As the whole arm is in a close-fitting cylinder displacement cannot easily take place, and the patient is quite comfortable.

Except to free the musculospiral nerve from callus operation is rarely necessary, for even if there is some over-riding of fragments a little shortening of the arm does not give rise to any serious impairment of function to the ordinary man.

All fractures through the condyles and indeed all fractures about the elbow, except fracture of the

olecranon, are best treated in the fully flexed position. For the first few days the forearm, fully supinated, should be bandaged to the upper arm in fullest flexion, after this it is sufficient to keep the wrist slung short up under the chin.

In dealing with cases of stiff elbow after fracture through the condyles, especially in children, even if there is backward displacement of the lower fragment, I always first attempt to secure full flexion.

Under an anesthetic, with the humerus and forearm protected by local splints, the elbow is forcibly flexed, breaking or twisting the recent callus. The arm is then bandaged in the most flexed position obtainable. It is a remarkable fact that callus in front of an elbow-joint when subjected to continuous pressure in this way is rapidly absorbed, so that in a few days the elbow can be further flexed.

If necessary, the process may be repeated a second or third time till nearly complete flexion is obtained. The elbow is then left fully flexed till all reaction has disappeared. Then a gradually increasing range of movement is permitted as has been already described.

Of course this treatment is not applicable to a case with actual bony ankylosis between the humerus and bones of the forearm, but such ankylosis is really very rare. If you can once get the callus on the move the progress toward recovery only requires about six weeks in the majority of cases.

In fractures of the shafts of the bones of the forearm the chief disability to be feared is inability to supinate the forearm completely. The trouble usually arises when both bones are broken. Here anatomical knowledge is of importance. The whole length of the posterior border of the ulna is subcutaneous and is practically straight. On this straight ulna the curved radius rotates like the handle of a bucket.

We must therefore attend to two points. First we must keep the ulna straight ; second, we must not interfere with the natural curve of the radius. That is to say, there must be no pressure of bandage or splint on the middle of the shaft of the radius.

With anterior and posterior wooden splints, the middle of the forearm is often allowed to sag into a curve. Once the ulna is allowed to bend, both upper and lower radio-ulna joints are thrown out of line. With gutter-shaped metal splints, which wrap themselves round the limb, the arm can be fixed with the ulna lying straight along the posterior splint and the radius will almost take care of itself so long as it is free to take its natural curve. This can be secured by fixing the splints at their two ends, at the wrist and elbow. When union has taken place, see that supination is possible before the callus is too hard to be twisted.

No mention is made of muscular action, because I hold that it is merely a reflex called forth by shifting of the parts. If the forearm is comfortably fixed in splints and slung across the body at right

angles to the arm, there will be no reflex muscular spasms. This question of muscular spasm will be dealt with more fully when dealing with the femur.

Movement of the fingers in forearm fractures seems to do good and not harm. It does not disturb the relations of the fractured bones, and provides a healthy physiological stimulus to the circulation and general trophic condition of the limb. In fact, if the patient cannot move his fingers without discomfort, it may be taken as an indication that there is something wrong. The surgeon should then ascertain if his alignment is faulty or if there is undue pressure.

Colles' fracture and Chauffeur's fracture, with or without fracture of the styloid process of the ulna, should give no trouble provided two things are attended to—first, the reduction of the displacement, and second avoidance of strain of the callus by injudicious passive movement. The lower end of the anterior aspect of the radius is concave, with a very pronounced curve toward the prominent anterior edge of the lower articular surface. This curve must be preserved or the joint will be out of alignment, and the patient will complain of pain and stiffness until nature has had time to make necessary readjustments.

After reduction, a good anterior pad of wool is placed in the concavity of the radius already referred to, a similar posterior pad is placed on the dorsum of the wrist-joint and carpus, rather to the radial

side. Firm pressure on these two pads maintains the correction.

Using sheet-metal splints the author puts a spiral twist on each. For the right arm the dorsal splint is twisted a half turn with the clock and the anterior splint a half turn against the clock. The lower end of the anterior splint should stop short with the radius, and must not encroach on the thenar eminence. A turn of sticking plaster at the wrist secures the two parts in position. A second turn near the elbow secures the other ends of the splints near the elbow. The dorsal splint need only extend half way down the dorsal aspect of the metacarpals. A bandage over all makes everything secure. The patient should be encouraged to move the fingers from the first. If this be impossible the surgeon should find out why.

The splints may be left on for five weeks, for instance when a pretty result with a minimum of callus is desired in a lady's wrist. If the fracture is properly set, there is no fear of a stiff wrist.

In the author's experience, stiff wrists after Colles' fracture are due to two causes : incomplete reduction and injudicious movement producing strain of young callus. Patients with a Colles' fracture often imagine they have "only a sprain," go home and apply cold water bandages for a day or even two, and then go to the surgeon with a painful swollen hand and wrist. When one of these cases appears lose no time, massage away as much of the swelling as possible, and reduce at once. Delay only

means increased difficulty in complete reduction, and the probability of more trouble from stiffness afterward.

The next point is that early passive movement of the wrist—not of the fingers—is apt to mean disturbance of the area of repair, and further reaction with pain and increased stiffness.

Cases with stiffness of the wrist and pain on any attempt at passive movement come for advice three to six months after the accident. There is a history that in spite of the most assiduous efforts to restore movement, the wrist has remained stiff and painful, and that the more it is moved the worse it is. In these cases a careful examination will nearly always reveal the fact that the deformity is not reduced. The presence of pain and reaction after movement is proof that the callus is still in an irritated or active condition and cannot be very hard. In such cases the author reduces with a Thomas wrench, applying the jaws of the wrench just as he would have applied his own scaphoids had the case been a recent one. This operation can be done under gas. Incidentally adhesions are broken down, and the fact that, when the patient wakes up with splints on, he can move his fingers as he could not do before, is a great encouragement to him.

There are other cases of malunion after a Colles' fracture of older standing, in which all pain at the seat of fracture is gone. The callus is solid, but the patient cannot use his hand well. In these it is

generally found that the patient cannot dorsiflex the wrist, and therefore the grasp of the hand is feeble. Such cases should be treated like cases of fracture of the carpal bones—by restoring dorsiflexion.

Fracture of Bones of the Carpus.—In the carpus, the bone most frequently fractured appears to be the scaphoid. Clinically the case appears at first to be a bad sprain. A diagnosis may be made, however, by the acute tenderness on pressure in the “anatomist’s snuff-box.”

The great disability complained of after this and similar injuries is stiffness and weakness of the fingers. On examination this is found to be due to inability to dorsiflex the wrist. Every schoolboy knows that the grasp of the hand is weakest when the wrist is flexed, and strongest when it is dorsiflexed, but surgeons have been strangely slow to put this knowledge to practical use. Stiff wrists are nearly always slightly flexed wrists, therefore the treatment is clearly to keep the wrist quiet in dorsiflexion till the storm is passed.

Having diagnosed a fracture of a carpal bone, the writer always dorsiflexes the wrist and puts it up in this position on a palmar splint of sheet metal, known for many years in Liverpool as the “cock-up” splint. If a fragment of the scaphoid is displaced backward and obstructs dorsiflexion, he first tries to press it back into position and then dorsiflexes the wrist. If this fails, the fragment should be removed at once, and the wrist put up in dorsiflexion. In cases of fracture the splint need not extend beyond the palm, the fingers being free.

In cases of stiff wrist with an inflammatory element, the palmar part of the splint should extend to the tips of the fingers until the inflammation has subsided.

As has been already indicated this treatment will increase the range of movement and improve the function of the wrist in certain cases of stiffness after old-standing Colles' fracture.

Fractures of the Lower Limb.—In dealing with fractures of the lower limb, especially with fractures of the femur, muscular action has always been a disturbing factor, tending to produce shortening and over-riding of fragments.

Let it be said at once that the writer never employs weight and pulley extension. Extension by weight and pulley is a most inefficient method of attempting to control muscular spasm. It is by reflex nervous impulses induced by changes of tension in the muscle, that muscular spasm is produced. A patient lying in bed with a fractured femur cannot avoid constantly changing the state of tension of the muscles of his thigh if he has a weight and pulley attached to his limb. The counterpoise is the weight of his body. Every time he tries to shift the position of his shoulders by digging his elbows into the bed, he alters the tension on his muscles calling forth a reflex spasm. When he falls asleep and his muscles relax, when he moves in his sleep, when he is lifted upon a bed pan, or moved slightly by the nurses to have his bed put straight, there must be a reflex contraction of his muscles.

because there is a sudden change in tension. The muscles are always on the alert. Liston with his long splint used a perineal band, and fixed the ankle down to the lower end of the splint. This form of extension was absolutely sound in principle, but was abandoned because the perineal band chafed and made the groin and perineum sore. The real reason for this was that the perineal band was cloth, absorbed perspiration, and became septic and irritating.

Nevertheless the best method of fixing the thigh is by fixed extension such as Liston used, only the method can be much improved on. To illustrate this point consider a fracture of the middle of the shaft of the femur, with extension strapping of adhesive plaster applied in the usual way to the sides of the limb right up to the seat of fracture. At the lower end of the extension strapping there is a loop of webbing to which is attached a length of strong bandage, or better still of ordinary lampwick. Next slip the ring of an ordinary Thomas knee splint over the foot and up to the groin till it is firm against the tuber ischii; pull the extensions tight; take a turn round each side bar; and tie the ends together over the bottom end of the splint which of course projects 8 or 10 inches beyond the foot. For further control, place behind the limb a gutter-shaped sheet-metal splint extending from the buttock fold to the lower third of the leg with a good wool pad in the hollow of the knee. On the front of the thigh place another sheet-

metal splint stopping short above the patella, and fasten the two together with a couple of circular bands. This gives excellent local control for the sheet-metal splints, each embracing nearly half the circumference of the limb. A couple of little transverse bandage slings suspend the posterior splint from the side bars of the knee splint, so that the center of the limb is exactly between the two side bars. The alignment from hip-joint to ankle joint is perfect, being dependent on a straight pull.

Now the patient may raise his shoulders. His other leg can even be moved without altering the tension on his thigh muscles, and there is no reflex spasm of the muscles. Further, even if the muscles try to contract they cannot, for the upper end of the splint is firm against the tuber ischii. The muscles, therefore, do not remain on the alert, but come to rest. Starting pains are unknown.

A little attention is necessary to prevent soreness of the perineum. The ring of the splint is covered with leather, a wipe with a soapy rag slipped between the splint and the skin keep both clean and polished. Finally the nurse must several times a day press down the skin of the buttock and draw a fresh part of skin under the splint. After a few days the patient becomes so used to the splint that this is no longer necessary, but with a very fat flabby patient, the skin may begin to show signs of redness in half an hour, and should therefore be attended to every half hour for the first day or two.

Having obtained the full length of the limb, all that is needed is to keep the extensions taut. This is a very different thing from hanging a weight of several pounds on to the limb to tire out the muscles.

All that is necessary is to prevent them from contracting. If a muscle has no play it is not nearly so ready to respond to reflex impulses as a muscle which is under elastic tension.

In a straightforward case where all the shortening has been corrected when the fracture was set, or within a day or two by tightening the extensions as the muscle relaxes, there is nothing more to do until the end of the fifth or sixth week by which time fair union has taken place. Now a walking calliper a quarter of an inch too long for the limb is substituted for the bed splint, and the patient is allowed to walk. As the splint is just a shade longer than the limb he cannot quite get his heel to the ground, and therefore is not really carrying weight. Swinging the limb along improves its nutrition, and generally aids in hastening the process of repair, for it is a modified form of the normal physiological function of the limb.

In dealing with malunited fractures of the shaft of the femur the same method of splinting is employed. First, however, there is the question of how to get rid of the over-riding. If there is tenderness and pain at the seat of fracture, especially if the deformity is increasing, it is quite safe to conclude that the callus is still soft, even though many

months have elapsed since the accident. In such a case by twisting and manipulating the limb the callus can be broken down. Then with block and tackle the muscles can be forcibly stretched as much as 2 inches or rather more at one sitting. The limb is then put up in the manner described, with fixed extension. Next day or the day after, the muscles will be adapted to their new length, and by tightening the extensions an overlapping of 3 or 4 inches can readily be corrected in a few days, and the limb made nearly if not actually as long as its fellow. At the same time with this straight pull, any angular deviations out of the true line are automatically corrected.

To deal with such cases, it is convenient to clip on to the bottom of the Thomas splint a small apparatus which consists of a central screw bolt at the end of which there is a little swingle bar to the ends of which the extensions are attached. As the muscles relax the nurse gives a turn to the screw and keeps the extension taut, in this way the muscles never get an opportunity of shortening, and it is astonishing to see how rapidly they relax. With this method one relies more on preventing contraction than on actually stretching the muscle by force except of course the pulling when the patient was under an anesthetic. That is very forcible. A good start means a great deal, but once the bone is started to move, it can be continued without much trouble.

In cases where the callus is already solid, I operate with the limb forcibly stretched with block

and tackle, endeavouring to correct the whole of the shortening there and then. If it is possible to get the whole of the shortening reduced at once, of course the next step is to fix with plates and put the limb up as already described.

Fractures of the neck of the femur are treated in a different way. The great deformity to be feared is that produced by the shaft travelling upward past the head and neck. Experience has proved that to avoid this varoid deformity the fracture should be treated with the limb in the abducted position. For this purpose, a double Thomas hip splint with the leg piece abducted is very convenient. The splint is fitted with extension bows. That is, a bow exactly like the lower end of a knee splint is attached to the ankle wings of the splint. Counter-extension is by a groin strap well padded and covered with leather. This is usually put on the opposite groin, partly to avoid having pressure near the injured hip, partly because this allows the pelvis to tilt a little toward the injured side, and so give a greater degree of abduction.

This apparatus and position are applicable to the treatment of all fractures above the trochanter minor whether in children or adults, of coxa vara in the active state, and of tuberculous disease of the hip. In fact, it is the position in which to treat any condition in which an adduction deformity at the hip is to be feared as a result.

It is equally suitable for the fracture of the femoral neck which occurs in infants as an obstetric

injury, for the separation of the epiphysis of the head of the femur, for the strains of the neck which occur during school life, and for the so-called extra-capsular fracture which occurs in young adults. It is also suitable for the treatment of intracapsular fracture in the aged, provided the patient can stand the recumbency and restraint. The least sign of hypostatic pneumonia is an indication for abandoning this method, putting the patient in a Thomas knee splint propping him up well or even getting him out of bed, and making the best of the fracture. Even under these unfavorable conditions these patients can get about wonderfully well in a walking calliper even if union should fail.

The fracture in young adults is usually caused by direct violence applied to the trochanter major. It is associated with splitting and broadening of the trochanter, and often is impacted. The question of disimpacting these fractures has been much discussed. My practice is to disimpact before setting if there is rotation or if there is any material shortening. Rotation outward of the foot is a much more serious deformity than a little shortening. If the foot is in good position without any outward rotation, and the shortening is not more than might reasonably be expected in any case, then it is not necessary to disimpact.

As already stated, I treat all fractures above the trochanter minor in abduction and rotation inwards, and all fractures of the femur below this point on a Thomas knee splint. The alleged disturbing action

of the psoas muscle in my experience does not occur. This is to be attributed not necessarily to errors of observation on the part of those who report it, but to the fact that with fixed extension, reflex contractions of muscles do not persist. I do not believe that the desire to contract, unless it is oppressed, is as inherent in muscle as if it were original sin. My whole experience in the treatment of fractures, as in the treatment of such conditions as spastic paralysis, is that if muscles are efficiently controlled they come to rest and cease to struggle, but that if the control is inefficient or intermittent then reflex action is active, and all muscles enervated from the same region of the cord share more or less in the excitability.

Similarly it is my experience that in supra-condylar fracture of the femur the lower fragment is not flexed by the action of the gastrocnemius after the first twenty-four to thirty-six hours, provided the limb is efficiently controlled. One of my former house surgeons has told me of a case in which he had direct ocular proof in a case of compound fracture in which the bone was exposed. He saw the bone gradually return into line with the femur by the end of the day after the accident. After this the wound began to granulate and no more was seen of the bone. The functional result was excellent.

Of fractures of the leg there is little to be said until the lower fourth of the leg is reached. Fractures above this are comparatively easy to

handle, even if both bones are broken, but in my experience fractures of the lower fourth of the tibia or of both bones in this region are extremely difficult to control even if the tendo-achilis be divided. The slightest error of alignment may mean constant pain and weakness in the ankle for months afterward.

Although I approach most other fractures with a feeling of confidence that I can treat them successfully by manipulation, I feel that in fractures of the lower fourth of the tibia and fibula operation is usually the wisest course for me. My usual practice is to attack the tibia. If it is secured with bone or metal plates the fracture of the fibula can usually be dealt with by manipulation.

I have frequently seen a wedge of bone knocked off the anterior and outer part of the lower end of the tibia. This may occur by itself or as a complication of a Pott's fracture. The detached fragment is liable to slip down a little and block dorsiflexion and therefore interferes with walking. The treatment in the first instance is to get the foot into extreme dorsiflexion thus pushing the fragment out of the way. If the foot is fixed in this position for a few days the condition will not recur. In old-standing cases, the patient comes with a history of an injury to the ankle or of a fracture in that region, and complains of pain over the front of the ankle-joint. On inspection the foot seems rather fuller than its fellow in this region. The X-ray photograph shows some irregularity of outline

chiefly due to irritation periostitis. The treatment is to operate, removing the offending portion of bone, and making sure that the foot can be completely dorsiflexed. If the patient declines operation, then the only thing to be done is to raise the heel of the boot so that the front of the astragalus does not impinge on the front of the tibia when walking.

There has recently been a great revival of interest in the treatment of fractures, stimulated by the revelations made by radiography, by the comparative impunity with which modern operative procedures can be attempted, and by a growing dissatisfaction with the functional results frequently obtained by traditional methods of treatment.

In a single short article it is manifestly impossible to do more than touch on the fringe of so vast a subject.

The question before the modern surgeon is not whether operative treatment is to supersede manipulative. The problem before each of us is how can we improve our skill and technic in both manipulative and operative treatment, and what means must we adopt in each individual case to give to our patients the surest, safest, and most complete restoration of function?

